



# A MULTI-SITE NETWORK w. ADDRESS TRANSLATION

## 1. Introduction

### 1.1. Objectives

This work aims to illustrate the address translation between local IP addresses and one public IP address in a multi-site network.

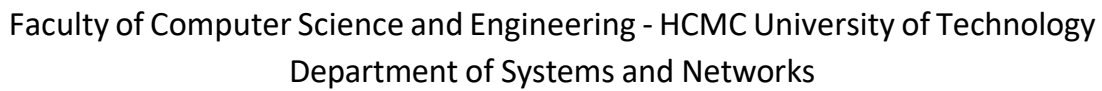
### 1.2. Outcomes

By completing this work through step-by-step guideline, students will be able to understand:

- Configuration Steps for NAT Address Translation: show the step-by-step process for configuring Network Address Translation (NAT) on a router, including defining inside and outside interfaces, specifying NAT rules, and applying appropriate access control lists (ACLs).
- Network Access to a Server Behind NAT: shows how to access a server located behind a NAT device, including the use of static NAT to ensure that incoming requests are correctly routed to the server.
- Packet Address Translation: shows how packet address translation works during data transmission, including the translation of source and destination IP addresses and ports, and the implications for both internal and external communications.

## 2. Testbed setup

In this section, we develop a multi-site network including 2 sites at LTK campus and DiAn campus. The site's communications are established through interconnected routers provided by ISP. Each site is equipped with a limited number of public IP addresses at a very high cost.



Due to the geographical separation, each site has an internal network (access network). Each internal network forms a subnet (or access network) with a gateway router. The connections among gateway routers are provided by ISP with public IP addresses. The network scheme is illustrated in [Figure 2.1](#).

Figure 2.1 Two site network system

### 2.2.1. Configure server with a static IP address and DHCP, HTTP service

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### Setup the static IP addresses

Site LTK	Site DiAn
Server 1 IP : 192.168.110.5	Server 0 IP : 192.168.120.5
Server 1 netmask: 255.255.255.0	Server 0 netmask: 255.255.255.0
Server 1 default gateway: 192.168.110.1	Server 0 default gateway: 192.168.120.1

### Setup the DHCP service

Site LTK	Site DiAn
Server 1 Interface : FastEthernet0	Server 0 Interface : FastEthernet0
Server 1 Pool Name: serverPool	Server 0 Pool Name: serverPool
Server 1 Default gateway: 192.168.110.1	Server 0 Default gateway: 192.168.120.1
Server 1 Start IP Address: 192.168.110.100	Server 0 Start IP Address: 192.168.120.100
Server 1 Subnet Mask: 255.255.255.0	Server 0 Subnet Mask: 255.255.255.0
Server 1 Max No User: 100	Server 0 Max No User: 100

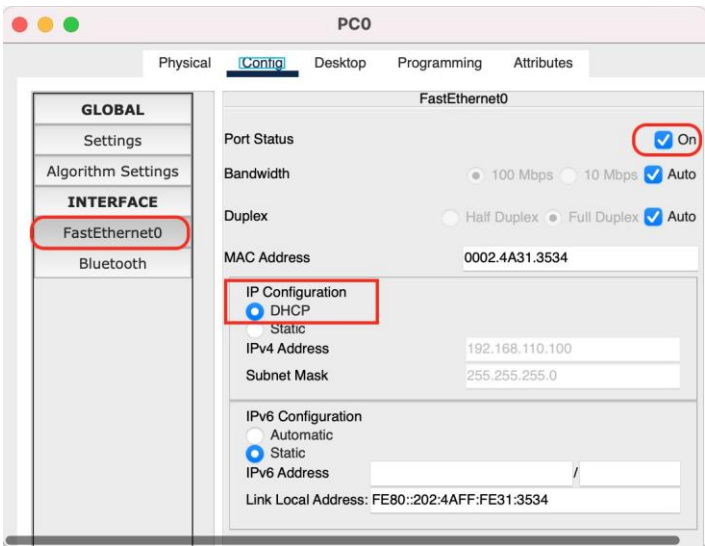
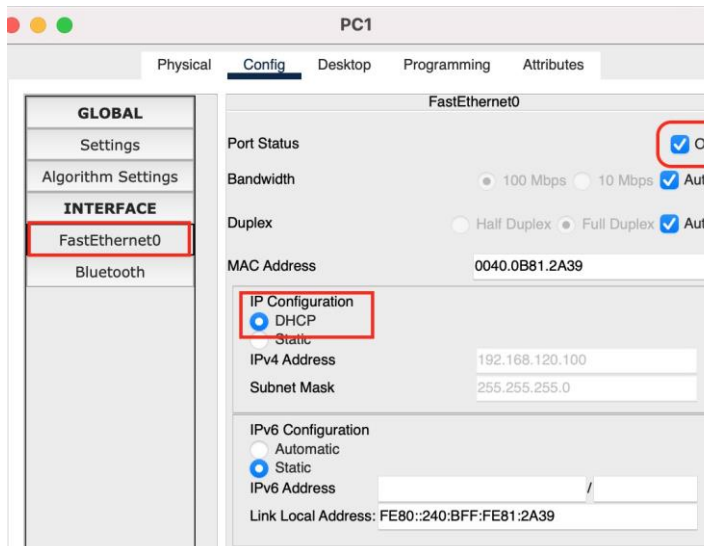
Pool Name	Default Gateway	DNS Server	Start IP Address	Subnet Mask	Max User	TFTP Server	WLC Address
serverPool	192.168...	0.0.0.0	192.168...	255.255...	100	0.0.0.0	0.0.0.0

Pool Name	Default Gateway	DNS Server	Start IP Address	Subnet Mask	Max User	TFTP Server	WLC Address
serverPool	192.168...	0.0.0.0	192.168...	255.255...	100	0.0.0.0	0.0.0.0



### 2.2.2. Configure PCs in DHCP client mode

On each PC, we enable DHCP (client) mode in the tab Config>Interface>FastEthernet0

PC 0	PC 1
	

### 2.2.3. Configure routers

Configure gateway router at site LTK

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Router>en
Router#configure terminal
Router(config)#interface GigabitEthernet 0/0/0
Router(config-if)#ip address 192.168.110.1 255.255.255.0
Router(config-if)#ip nat inside
Router(config-if)#no shutdown

Router(config)#interface GigabitEthernet 0/0/1
Router(config-if)#ip address 172.28.16.1 255.255.255.252
Router(config-if)#ip nat outside
Router(config-if)#no shutdown
Router(config-if)#exit

Router(config)#access-list 1 permit 172.28.16.0 0.0.0.3
Router(config)#access-list 1 permit 192.168.110.0 0.0.0.255
```



```
Router(config)#ip nat inside source list 1 interface GigabitEthernet 0/0/1 overload
Router(config)#ip nat inside source static tcp 192.168.110.5 80 172.28.16.1 1111
Router(config)#ip nat outside source static tcp 172.28.16.1 1111 192.168.110.5 80

Router(config)#router ospf 6000
Router(config-router)#network 172.28.16.0 0.0.0.3 area 0
Router(config-router)#exit
Router(config)#exit
Router#wr
Building configuration...
[OK]
```

### Configure gateway router at site DiAn

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Router>en
Router#configure terminal
Router(config)#interface GigabitEthernet 0/0/1
Router(config-if)#ip address 192.168.120.1 255.255.255.0
Router(config-if)#ip nat inside
Router(config-if)#no shutdown

Router(config)#interface GigabitEthernet 0/0/0
Router(config-if)# ip address 172.28.18.2 255.255.255.252
Router(config-if)#ip nat outside
Router(config-if)#no shutdown
Router(config-if)#exit

Router(config)#access-list 1 permit 172.28.18.0 0.0.0.3
Router(config)#access-list 1 permit 192.168.120.0 0.0.0.255

Router(config)#ip nat inside source list 1 interface GigabitEthernet 0/0/0 overload
Router(config)#ip nat outside source static tcp 172.28.18.2 2222 192.168.120.5 80
Router(config)#ip nat inside source static tcp 192.168.120.5 80 172.28.18.2 2222

Router(config)#router ospf 6000
Router(config-router)#network 172.28.18.0 0.0.0.3 area 0
Router(config-router)#exit
Router(config)#exit
Router#wr
Building configuration...
[OK]
```



### Configure inter-connected routers (Note: check your router model use FastEthernet or GigabitEthernet)

```
Would you like to enter the initial configuration dialog? [yes/no]: no
Router>en
Router#configure terminal
Router(config)#interface FastEthernet0/0
Router(config-if)#ip address 172.28.16.2 255.255.255.252
Router(config-if)#no shutdown

Router(config)#interface FastEthernet0/1
Router(config-if)# ip address 172.28.18.1 255.255.255.252
Router(config-if)#no shutdown
Router(config-if)#exit

Router(config)#router ospf 6000
Router(config-router)#network 172.28.16.0 0.0.0.3 area 0
Router(config-router)#network 172.28.18.0 0.0.0.3 area 0
Router(config-router)#exit
Router(config)#exit
Router#wr
Building configuration...
[OK]
```

### 2.2.4. Verify the address translation configuration

#### Verify the configuration of the gateway router at site LTK:

```
Router>en
Router#show ip nat statistics
Total translations: 1 (1 static, 0 dynamic, 0 extended)
Outside Interfaces:GigabitEthernet 0/0/1
Inside Interfaces:GigabitEthernet0/0/0
Hits: 0 Misses: 0
Expired translations: 0
Dynamic mappings:

Router#show access-lists 1
Standard IP access list 1
    permit 172.28.16.0 0.0.0.3
    permit 192.168.110.0 0.0.0.255
```



```
Router#show ip nat translations
Pro  Inside global      Inside local      Outside local      Outside global
tcp  172.28.16.1:1111    192.168.110.5:80  ---                ---
tcp  ---                ---              192.168.110.5:80  172.28.16.1:1111
```

For each gateway router, we need to verify the inside and outside interfaces, access list and static NAT address translations.

#### Verify the configuration of the gateway router at site DiAn:

```
Router>en
Router#show ip nat statistics
Total translations: 1 (1 static, 0 dynamic, 0 extended) Outside
Interfaces: GigabitEthernet0/0/0
Inside Interfaces: GigabitEthernet0/0/1
Hits: 0 Misses: 0
Expired translations: 0
Dynamic mappings:

Router#show access-lists 1
Standard IP access list 1
    permit 172.28.18.0 0.0.0.3
    permit 192.168.120.0 0.0.0.255

Router#show ip nat translations
Pro  Inside global      Inside local      Outside local      Outside global
tcp  172.28.18.2:2222    192.168.120.5:80  ---                ---
tcp  ---                ---              192.168.120.5:80  172.28.18.2:2222
```

For each gateway router, we need to verify the inside and outside interfaces, access list and static NAT address translations.

## 3. Packet Tracing

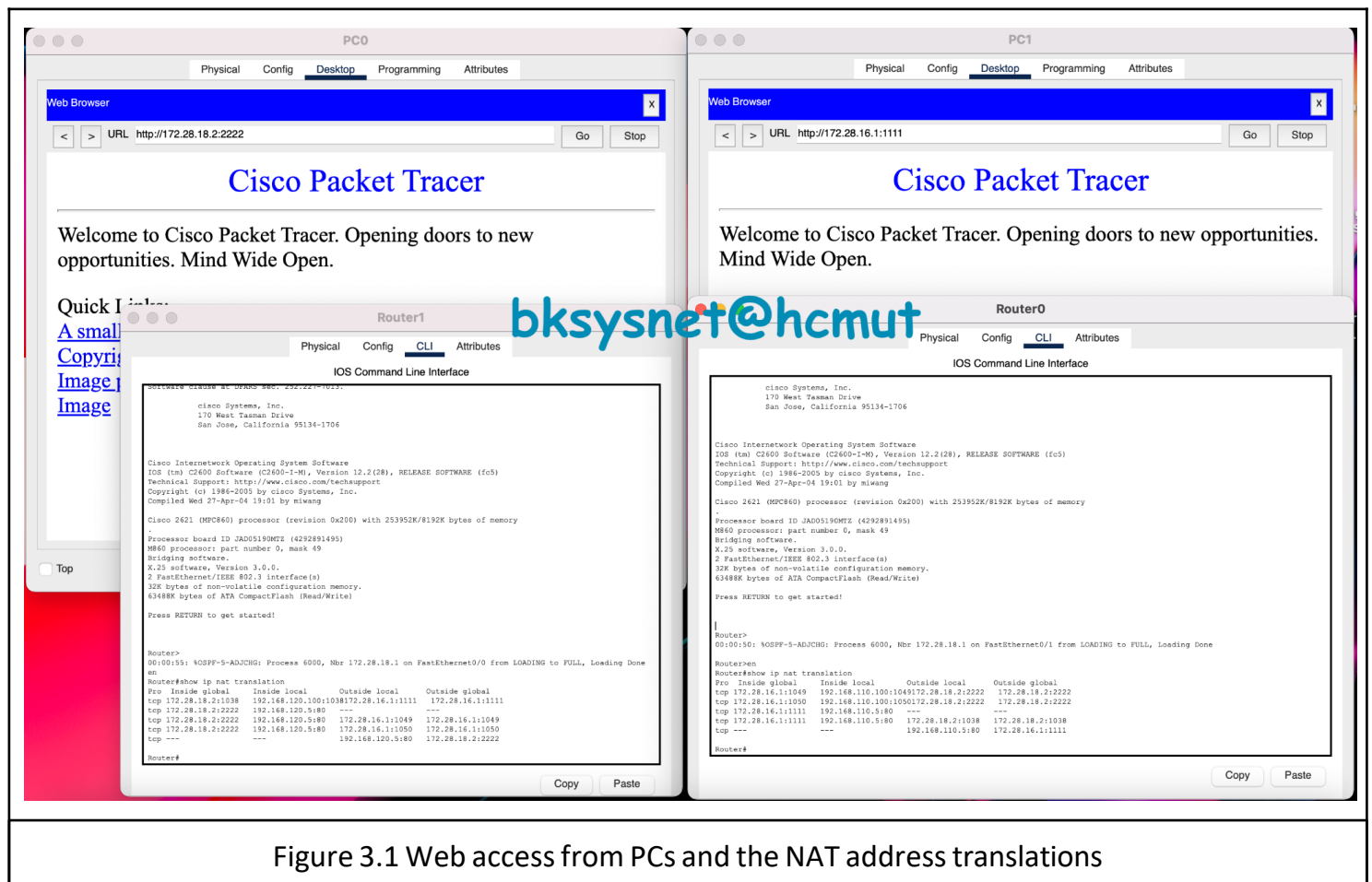
In this section, we perform external access through address mapping into the site's internal web server. On each PC, we access through the gateway router public IP address with static NAT port mapping. In each access, the NAT service will automatically translate between the inside and outside through an entry in the NAT address translation table.

Figure 3.1 shows the successful web browser accesses and the content of NAT address translation table.

In the following sections, we perform a tracing of the packet sending from PC0 at the site LTK to the HTTP web server at the site DiAn. We show the address translation progress at the gateway router by comparing the addresses between the NAT inside area and the NAT outside area.

From outside of the site LTK, the HTTP web server can be accessed at **http://172.28.16.1:1111**.

From outside of the site DiAn, the HTTP web server can be accessed at **http://172.28.18.2:2222**.



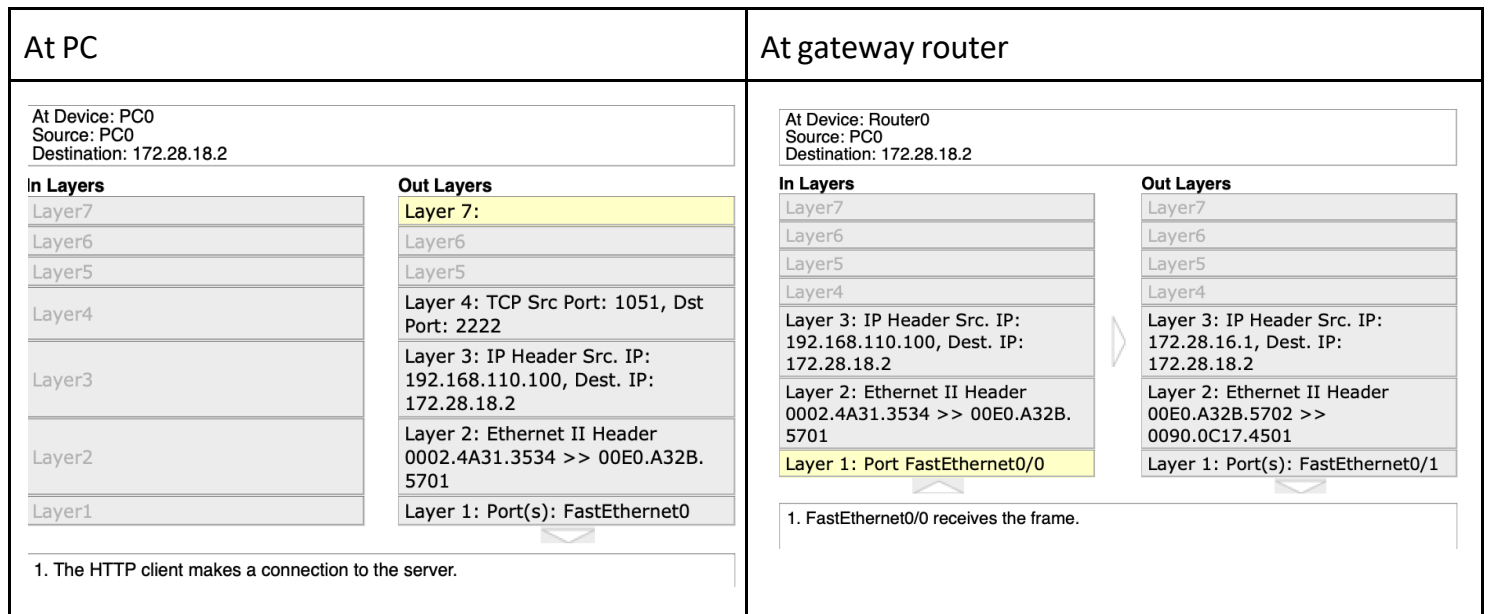


### 3.1. Site LTK

The NAT address translation table:

```
Router>en
Router#show ip nat translation
Pro  Inside global      Inside local      Outside local      Outside global
tcp  172.28.16.1:1050   192.168.110.100:1050  172.28.18.2:2222   172.28.18.2:2222
tcp  172.28.16.1:1051   192.168.110.100:1051  172.28.18.2:2222   172.28.18.2:2222
tcp  172.28.16.1:1111   192.168.110.5:80     ---               ---
tcp  172.28.16.1:1111   192.168.110.5:80     172.28.18.2:1038   172.28.18.2:1038
tcp  ---              ---                 192.168.110.5:80   172.28.16.1:1111
```

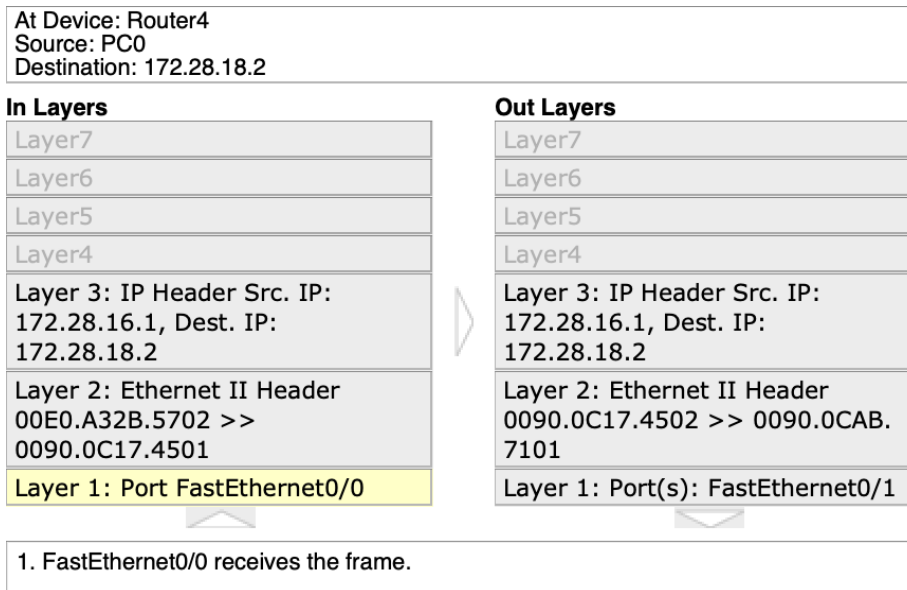
The packet address is translated the source addresses from inside 192.168.110.100 to 172.28.16.1





## 3.2. At the interconnected router

The packet addresses are public addresses: 172.28.16.1 and 172.28.18.2



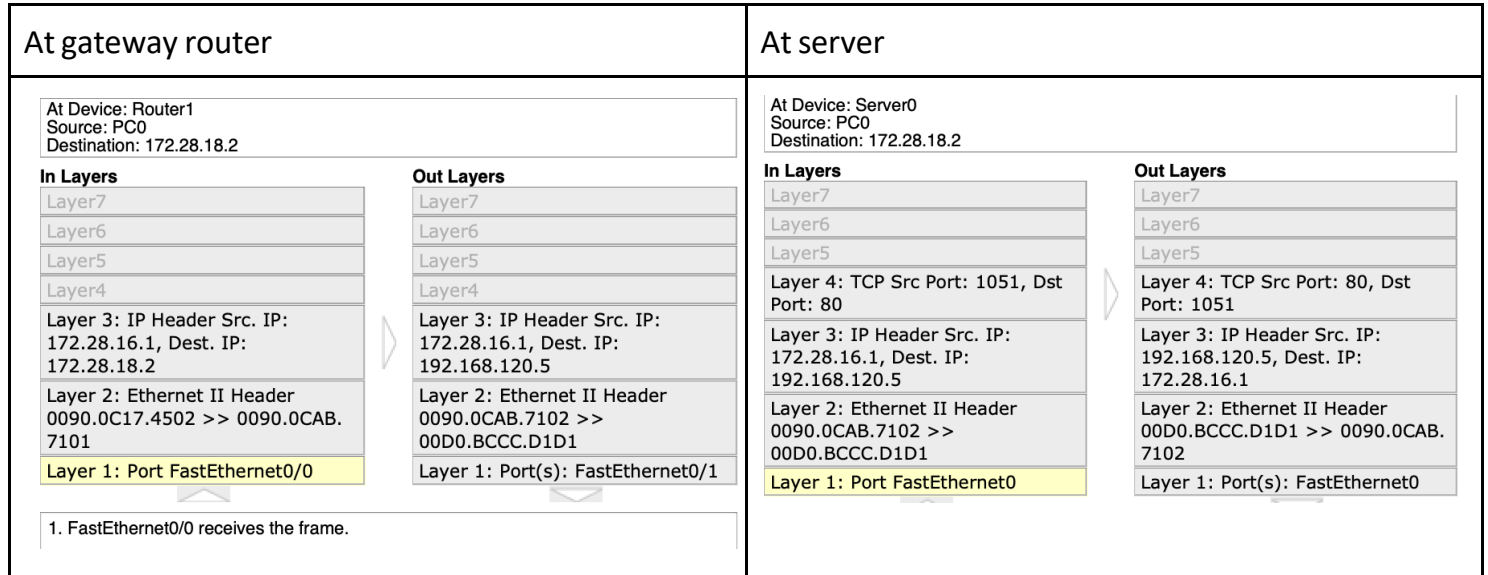
## 3.3. Site DiAn

The NAT address translation table

```
Router#show ip nat translation
Pro  Inside global      Inside local      Outside local      Outside global
tcp  172.28.18.2:1038    192.168.120.100:1038  172.28.16.1:1111  172.28.16.1:1111
tcp  172.28.18.2:2222    192.168.120.5:80     ---                ---
tcp  172.28.18.2:2222    192.168.120.5:80     172.28.16.1:1050  172.28.16.1:1051
tcp  172.28.18.2:2222    192.168.120.5:80     172.28.16.1:1051  172.28.16.1:1051
tcp  ---                ---                  192.168.120.5:80  172.28.18.2:2222
```



The packet address is translated the destination addresses from inside 172.28.18.2 to 192.168.120.5



## 4. Conclusions

In this work, we perform the address translation between the inside NAT address and outside NAT address. We verify the address translation at each gateway router of both sites LTK and DiAn. The address translations are examined at each router hop associated with the NAT address translation table entries. This packet tracing helps illustrate the NAT address translation in the course CO3093 and CO3094 at HCMUT.